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Research Paper

# An Analysis of Financing Innovation and Commercialization in Canada's Functional Food and Nutraceutical Sector

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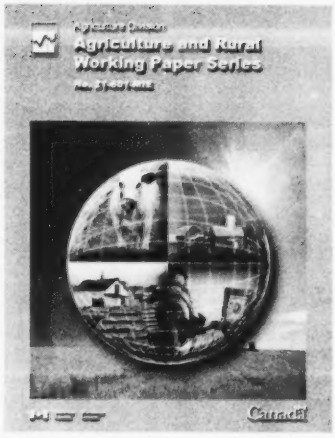


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## Abstract

Growing consumer interest in functional foods and nutraceuticals has been seen as a significant business opportunity for the agri-food sector. Many of the new firms in this sector are small and medium sized enterprises (SMEs). These SMEs often face difficulties in obtaining financing for their functional food and nutraceutical innovation activities. We develop and implement two models to show what factors affect a firm's decision to seek external financing and the level of financing obtained. Firm size, being privately held and engaging in contractual arrangements, have negative impacts on the likelihood of a firm seeking external funding, while firms which are intensively involved in the functional food and nutraceutical sector, with greater prospects for business expansion and/or are involved in partnerships are more likely to seek external financing. Larger firms and those involved in functional food and nutraceutical research and development receive a greater amount of capital when they decided to raise capital. However, firms focused on functional foods and nutraceuticals, as opposed to more diversified firms, and those involved in product development and concept scale-up receive less capital. Our findings highlight the importance of public support in addressing the capital requirements of functional food and nutraceutical firms and underscore the considerable burden in this respect borne by smaller sized firms.

*Keywords*: Functional foods; Nutraceuticals, Economics, Finance, SMEs

## Introduction

Recent consumer research in Canada suggests that consumers are increasingly aware of functional foods and nutraceuticals and value the potential health benefits associated with a range of functional ingredients (West *et al.*, 2002; AAFC, 2004; Health Canada, 2005). Indeed, there is evidence that consumers have moved beyond awareness; a growing proportion of consumers have tried functional foods and nutraceuticals, with a significant minority using such products on a regular basis. Such trends are not unique to Canada, and are being observed in many industrialized country markets. Market research data for the period 2002 to 2004 (AC Nielson, 2004) suggest that, among the seven food and beverage product categories with the greatest rates of growth in sales, six categories were health-promoting products. Not unsurprising, functional foods and nutraceuticals have been recognized as a significant business opportunity for the agri-food sector and, at the same time, a potentially effective means to promote health and well-being in the population and to reduce health-related costs (Malla *et al.* 2005).

Recognizing the market potential for functional foods and nutraceuticals, a number of firms in Canada have begun to capitalize on these emerging markets. While data is somewhat limited, it is estimated that the Canadian nutrition sector grew eight percent over the period 2002 and 2003, with an estimated value of nearly US$5 billion in 2003 (Nutrition Business Journal, 2004). The majority of firms in the Canadian functional food and nutraceutical sector are small and medium-sized enterprises (SMEs); a 2003 survey (on which the analysis reported below is based) of firms engaged in this sector found that around 50 percent of firms had less than 20 employees, while 85 percent had less than 100 employees. The key focus of this paper is the extent to which firms face difficulties in exploiting opportunities in the functional food and nutraceutical sector predominantly due to problems accessing finance and, in turn, the extent to which this relates to the predominance of SMEs.

Kamien and Schwartz (1978, p. 252) observe: "among the leading characteristics commonly associated with industrial research and development, one of the most prominent is the virtual necessity for it to be financed internally from a firm's current profits and accumulated funds." This reliance on self-financing often arises as financiers and investors ration capital to minimize exposure to risk (or to seek out a higher risk-adjusted rate of return). Problems accessing capital are a predominant obstacle for SMEs seeking to finance their innovation activities through sources external to the firm. Indeed, the literature suggests a disparity between the rate of return required by entrepreneurs investing their own funds and that required by external investors (Hall, 2005). A variety of reasons for the expectation of higher rates of return among external financiers are documented in the literature. Arrow (1962) notes the moral hazard problems associated with external financing of risky innovative activities, whereby a detailed account of such activities are not provided to the external financier due to the risk of leaking confidential proprietary information. Thus, the reluctance of innovative firms to reveal their ideas to financial markets (because of the non-rival nature of such information) reduces the quality of the signal the firm can deliver about a potential project (Bhattacharya, and Ritter, 1983). It is argued, therefore, that due to these informational asymmetries and moral hazard problems, innovative activities are difficult to finance in a freely-competitive market (Nelson, 1959; Arrow, 1962, Trester, 1994, Gompers, 2001).

An added ramification to the signalling problem associated with raising capital for innovative activities is the significant informational rent created by the highly regulated nature of the functional food and nutraceutical sector, especially in the case of novel foods. Scientific uncertainty regarding the efficacy of functional foods and nutraceutical can aggravate informational frictions between the lender and the

borrower. Further, there may be risks associated with the protracted process of approval of novel foods. Innovative activities of this kind are hard to monitor due to information asymmetries and there is a significant potential for the misalignment of interests between the innovating firm and providers of external financing.

In addition to the problems of information asymmetry and moral hazard associated with raising capital for research and development, there is frequently a lack of collateral, especially among SMEs, because of the dominant role of human capital (in the form of highly educated and skilled scientists) in the innovation process. Limited collateral may constrain the ability of innovative firms, and especially SMEs, to borrow, presenting perhaps a *prima facae* case for government to act as a source of financing. Addressing such difficulties, however, requires a better understanding of the factors that mitigate a firm's ability to undertake innovation, specifically in the current context of functional foods and nutraceutical development and commercialization. An unknown in this regard is the capacity of firms in the functional food and nutraceutical sector to respond to the emerging demand for such products and the constraints that hinder their efforts.

Development and commercialization of functional foods and nutraceuticals share many of the characteristics of advanced food innovation, but also have certain unique attributes, in particular where these are the product of biotechnology. Thus, for example, such products may not have been produced and consumed in the Canadian context previously and are subject to prior regulatory approval as novel products (Health Canada, 2005). Further, the ability to make health-related claims on functional foods and nutraceuticals is strictly controlled and, within the limits of current regulations, is dependent on the availability of scientific evidence demonstrating health benefits. Broadly, these regulatory processes influence the nature of product development and commercialization, enhancing levels of capital intensiveness, including both physical resources and human capital, and having an effect on the level of risk associated with new innovation. This can further exacerbate the problems experienced by innovative firms in raising external finance, such that capital rationing is the norm rather than the exception.

The current paper seeks to enhance understanding of the ability of firms in the functional food and nutraceutical sector in Canada to raise capital in pursuit of product development and commercialization. Specifically, it explores the characteristics of firms that seek external financing and those that are successful in this pursuit, highlighting those factors that tend to facilitate or impede access to capital and the amount of financing that is raised. Data are obtained from the Functional Food and Nutraceutical Survey (FFNS) undertaken by Statistics Canada in 2003. This survey provides relatively detailed information on the nature of firms engaged in the functional food and nutraceutical sector. Using these data, the analysis below presents the first in-depth assessment of the role of external financing in the functional food and nutraceutical sector, and indeed advanced food innovation more generally, not only in Canada but internationally.

## Conceptual Framework

There are many determinants of a firm's propensity to seek capital to finance their innovation activities and product commercialization (Hall 2002, 2005). This creates methodological challenges in seeking to determine the impact of a given firm or sector-specific characteristic. Indeed, we have a rather imprecise understanding of the direction and magnitude of the impact a particular characteristic has on a firms'

propensity to raise capital, both generally and in the specific context of the functional food and nutraceutical sector.

Much of the early work on firm-level capital seeking focused on deriving optimality rules to guide what factors shape the level of investment a firm requires. This work was often undertaken in the context of investment in capital stock in neoclassical growth models (see Aghion and Howitt 1997), or investment in research and development/innovation in decision or game theoretic settings (see, for example, Kamien and Schwartz 1982). We assume an innovating firm seeks external financing as an input to a production process. In this case, the production process has ideas and knowledge (i.e. human capital) as an output which leads directly or indirectly to development of revenue-generating output (either a physical product, an intellectual product or a service). In this sense, the firm could be viewed as determining the expected profit maximizing level of investment. Such an approach leads to an optimality condition for investment which equates the expected marginal value product of investment in research and development/innovation (i.e. the firm's derived demand for capital) to the (marginal) cost of capital (i.e. the supply of capital).

Derived demand for capital manifests itself via business plans and proposals presented to external financiers. Experience and observation of the marketplace tells us that such business plans and proposals are complex and reflect much more than the expected marginal value product. Indeed, characteristics of the firm, its capabilities, partnerships, experience and overall scope for success will all be articulated in these proposals. Moreover, such derived demands will have a choke price (or choke interest rate) at which the firm would choose not to seek external financing. Financiers, in turn, will often have a threshold level of return (or interest rate) which must be satisfied in order for a project to be successful in accessing capital. This threshold could be viewed as a shutdown point (to draw an analogy to neoclassical economic behaviour), where the financier is best viewed as a supplier of capital. If the threshold return exceeds the choke price, and assuming supply and demand functions are well behaved, then the firm will optimally choose not to seek external financing. Recognize also that the financier may discount the anticipated return to a project such that the choke price on the derived demand curve falls below the shutdown point. In this case, even if the firm seeks capital, discounting by the financier is such that the firm is not successful. If, on the other hand, the threshold return is less than the choke price then a non-zero level of optimal investment exists. In this case, the matching of the firm's derived demand for investment funds with the financier's supply of funds will occur when mutually agreeable terms of trade are established.

This exchange will manifest itself in investment by the financier in the firm. The resulting level of investment will depend on a number of exogenous factors. Clearly, factors exogenous to the firm and the financier will play a role. However, given the many different sources of external financing, and the relatively large amounts of capital that are generally available, we assume that the supply of capital is perfectly elastic. Such a view is entirely consistent with the notion of a threshold level of return required by financiers. As such, the factors driving access to, and obtaining of, investment funds (i.e. capital) reflect the characteristics of the firm seeking such funds.[1] Assuming a perfectly elastic supply of capital allows us to formulate a reduced form model relating the decision to seek investment (or the level of capital obtained) in terms of factors specific to the firm seeking funds. Firms with characteristics which prove useful in demonstrating scope for potential success will gain access to funds.

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1. We recognize that the nature of the financier may also play a role. For instance, different financiers may have different thresholds. However, it could be argued that such differences will be eroded via competition in the capital market, such that individual thresholds converge on a common threshold (perhaps with slight adjustment for risk).

The literature is replete with studies examining the factors influencing research and development and innovation financing (see Hall 2002; 2005 for a recent discussion). However, much of the previous work in this area has focused on the role of financial and liquidity constraints. Yet, other factors are also surely important. In this regard we note that the literature is relatively silent in terms of explaining other factors which might influence which firms seeks capital and, in turn, what influences how much capital is actually received. We conjecture that a firm's propensity to access capital is influenced by a variety of observable and measurable firm and sector-specific characteristics. These characteristics reflect: firm size and the intensity of involvement in the functional food and nutraceutical sector; prospects for business expansion; types of activities related to development/commercialization undertaken by the firm; firm ownership structure; distribution channels utilized by the firm; business practices of the firm; and the disease focus of functional foods and/or nutraceuticals produced by the firm.

Firm size has been found to be an important driver of the intensity of firm innovation (see for example Traore 2004; van Moorsel 2005). The rationale for including firm size here relates to the fact that larger firms may be better able to spread research and development costs over more projects, in turn facing lower capital requirements per unit of innovative output and requiring less external financing. As well, larger firms may be better suited to self-financing, which again would lower the need for external sources of capital. Smaller firms may require external financing as a means of remaining viable as their capital burn rate is typically greater than for larger firm, while smaller firm's may have no (or little) revenue from which to finance innovation. Regardless, scope exists for an inverse relationship between firm size and capital requirements through external sources. On the other hand, larger firms could face more stringent financial or liquidity constraints and therefore require additional outside financing.

A firm's intensity of involvement in the functional food and nutraceutical sector and prospects for business expansion are included to reflect the positioning of the firm and their scope for future growth. The functional food and nutraceutical sector is growing at a fast rate (Nutrition Business Journal, 2004). Large sectoral growth rates might give financiers cause to view firms in that sector more favourably when the firm seeks funds. Intensity is included to reflect that some firms in the sector devote themselves to developing and marketing of functional food and nutraceutical only, while others view such products as complementary to their existing suite of products in other areas. Given growth in the sector, a firm which devotes a large amount of its resources to functional foods and nutraceuticals may be more like to receive capital (and possibly more capital) as it will "ride the growth" of the functional food and nutraceutical sector. Prospects for business expansion reflect the same notion.

Van Moorsel *et al* (2006) found positioning within the spectrum from product development to "goods on the market" is an important factor in shaping the innovative capacity of firms in the Canadian biotechnology sector. In this regard, the types of activities a firm undertakes related to functional food and nutraceutical product development and commercialization are included to reflect the firms' relative position within the sector. For instance, some firms position themselves in the development stage of the market, while other focus on commercialization (i.e. marketing) of products. The capital requirements for functional food and nutraceutical product development are different from those needed for marketing such products. Moreover, the nature of the market place in the various stages of the functional foods and nutraceuticals market differ; various market levels in the functional food and nutraceutical sector are more competitive than others, while others are more regulated. Such differences may affect a firm's propensity to obtain capital and, as such, are included here.

Various factors related to the firm are also included. These include firm ownership structure, the distribution channels utilized by the firm and the firm's business practices. While largely driven on an empirical basis, many antecedents to this paper have found such factors to be important. Moreover, if policy is to be shaped in a way that better enables access to capital, understanding how these factors may (or may not) play a role could be useful. Lastly, to reflect the fact that various disease states may offer more economically beneficial outcomes, the disease focus of the functional foods and/or nutraceuticals produced by the firm are also included. The notion here is that a firm developing (or marketing) a product which addresses a widespread and/or severe disease states may have a greater propensity to obtain capital than a product which prevents a disease with less severe health outcomes.

## Empirical Framework

The previous section outlined an approach to conceptualizing a reduced form model where the capital a firm receives depends on its propensity to obtain capital. Given the nature of external financing sources, this propensity is argued to depend on the nature of the firm seeking funding. The question now becomes how one might capture this notion empirically. We denote this propensity with the variable $D_i$, such that higher values of $D_i$ represent a higher propensity. The value of this propensity index ($D_i$) for a particular firm depends on a 1xm vector of factors ( $\mathbf{X}_i$ ) pertaining to that firm and a random error term $\varepsilon_i$:

$$\Pr opensity_i = \mathbf{X}_i\beta + \varepsilon_i = Z_i + \varepsilon_i \qquad (1)$$

where $\beta$ is a mx1 vector of unobserved parameters and $Z_i = \mathbf{X}_i\beta$. Since $D_i$ is not observable, it is treated as a "latent" variable. We use this latent variable approach to develop a model which explains the probability that a firm attempts to obtain capital. If $D_i$ is above a threshold value ($\alpha$), the firm is defined as a "seeker" (of capital), and the variable *attpt* (attempt to raise capital) equals 1. On the other hand, if $D_i < \alpha$, the firm is defined as a "non-seeker" and *attpt* = 0.

As discussed previously, the propensity to seek capital varies according to a range of firm and sector-specific characteristics. We assume that the probability of a given firm making a choice to be a "seeker" or "non-seeker" is a function of these characteristics. Therefore, the probability of a given firm choosing to raise capital can be characterized using the relationship in equation (1) in the following manner:

$$\Pr(Y_i = 0) = \Pr(\mathbf{X}_i\beta + \varepsilon_i < \alpha) \qquad (2)$$

$$\Pr(Y_i = 1) = \Pr(\mathbf{X}_i\beta + \varepsilon_i \; ¡Ý\alpha) \qquad (3)$$

Since equations (2) and (3) capture all probabilities of the random variable $\varepsilon$, such probabilities can be characterized by a cumulative probability density function (Davidson and MacKinnon, 1993). We have selected the normal cumulative density function to characterize $\varepsilon$, in which case the probability model represented in (2) and (3) is a bi-variate probit model. Maximum likelihood methods are used to estimate the value of $\beta_k$ that maximizes the joint probability of observing a given sample. Thus, once the parameters of the model are estimated, it is possible to compute probability of an individual firm not-seeking capital ($\Pr(Y_i=0)$) and seeking capital ($\Pr(Y_i=1)$), as well as the marginal effects (i.e. change in the probability of seeking or not-seeking financing) arising from changes in the explanatory variables.

While capital-seeking is an interesting issue influencing innovation and commercialization in the functional food and nutraceutical sector, the amount of capital received by firms is perhaps a more important issue. Thus, we also explore the factors influencing the amount of capital received by firms in the functional food and nutraceutical sector. Note, however, that the decision to seek or not seek capital is not a random outcome within the sample; "capital seeker" and "capital non-seeker" status is unlikely to be a random outcome with important systematic differences between these two groups. Firms who received zero capital may have a systematic association with certain firm characteristics if such zero capital outcomes are due to "non-seeker" status. Thus, the amount of capital received by "capital seekers" may not, in general, provide a reliable estimate of what "capital non-seekers" would have received had they decided to raise capital.

The capital-seeking decision-making process is thus sequential, where the dichotomous outcome (seeker or non-seeker) is followed by a continuous outcome (the amount of capital received). The Heckman two-step approach (Heckman, 1976) has been extensively used in estimating such dichotomous-continuous models. In this procedure, a probit model, reflecting the dichotomous decision, is estimated in the first stage and a regression equation with a continuous non-zero dependent variable is estimated in the second.

Suppose the amount of capital raised (a dependent variable of continuous outcome) is *dollar*. Thus, we have the following relationship between *dollar* and a set of firm characteristics (again denoted with the 1xm vector $\mathbf{X}_i$):

$$dollar_i = \mathbf{X}_i\boldsymbol{\delta} + \varepsilon_i \tag{4}$$

However, this dependent variable is only observable for firms who choose to seek capital, with the decision to seek capital represented by the following relationship:

$$\Lambda_i^* = \mathbf{W}_i\boldsymbol{\gamma} + u_i \tag{5}$$

where $\Lambda_i^*$ is a latent variable, $\mathbf{W}_i$ is a 1xm vector of explanatory variables, $\boldsymbol{\gamma}$ is a mx1 vector of unobservable parameters, and *dollar* will be observed only when $\Lambda_i^* > 0$. Note that $\mathbf{W}_i$ and $\mathbf{X}_i$ are covariates that are based on a range of firm characteristics and have systematic associations, respectively, with the dichotomous and continuous outcomes. However, it is possible that some covariates are common to both stages of the decision-making process. These two outcomes are modeled by characterization of the two error terms $u_i$ and $\varepsilon_i$ (Green, 2003). The expected amount of capital raised, given that a firm seeks to raise capital, is given by equation (6):

$$E(dollar_i | dollar_i \text{ observed}) = E[dollar_i \mid \Lambda_i^* > 0] \tag{6}$$

$$= E[dollar_i \mid u_i > -\mathbf{W}\boldsymbol{\gamma}_i] \tag{7}$$

$$= \mathbf{X}_i\boldsymbol{\delta} + E[\varepsilon_i \mid u_i > -\mathbf{W}\boldsymbol{\gamma}_i] \tag{8}$$

Suppose $u_i$ and $\varepsilon_i$ have a bivariate normal distribution with zero means and correlation $\varrho$. Using the theorem for the moments of the incidentally-truncated bivariate normal distribution[2] (Green, 2003 p. 781), we can derive:

$$E(dollar_i|dollar_i \text{ observed}) = \mathbf{X}_i\delta + \varrho\sigma_\varepsilon\lambda_i(\alpha_u) \qquad (9)$$

where $\lambda_i(\alpha_u) = \dfrac{\varphi(\mathbf{W}_i\gamma/\sigma_u)}{\Phi(\mathbf{W}_i\gamma/\sigma_u)}$ is the inverse Mills ratio from the probit estimate of the dichotomous outcome, $\Phi(\mathbf{W}_i\gamma/\sigma_u)$ is the cumulative normal density and $\varphi(\mathbf{W}_i\gamma/\sigma_u)$ is the probability distribution function for the normal distribution. It is the inclusion of the Mills ratio which controls for the sequential decision making process (i.e. controls for sample selection issues in our dichotomous-continuous outcome), and permits the role that factors in $\mathbf{X}_i$ play in shaping the amount of capital received to be recovered. We use the maximum likelihood method with Heckman's two step estimation procedure to estimate $\gamma$ for the dichotomous process and $\delta$ for the continuous process.

## Data and variables

Data for this analysis was obtained from a 2003 survey of the functional food and nutraceutical sector (FFNS survey) conducted by the Small Business and Special Survey Division of Statistics Canada on behalf of Agriculture and Agri-Food Canada. The sample frame was developed using firms who had indicated that they are engaged in activities related to functional foods and nutraceuticals activities in the Biotechnology Use and Development Survey (BUDS) undertaken in 2001. The sample frame included 576 firms, of which 146 indicated that they were still engaged in activities related to functional food and nutraceutical sector (Table 1). Of these 146 firms, 78 self-identified as having activities related to nutraceuticals, 27 firms self-identified as having activities related to functional foods and 41 firms indicated activities in both sectors.

2. If $u_i$ and $\varepsilon_i$ have a bivariate normal distribution with means $\mu_u$ and $\mu_\varepsilon$, standard deviations $\sigma_u$ and $\sigma_\varepsilon$, and correlation $\rho$ then $E[u \mid \varepsilon > a] = \mu_u + \varrho\sigma_u\lambda(\alpha_\varepsilon)$ and $\text{var}[u \mid \varepsilon > a] = \sigma_u^2[1 - \varrho^2\delta(\alpha_\varepsilon)]$, where $\alpha_\varepsilon = (a - \mu_\varepsilon)/\sigma_\varepsilon$; $\lambda(\alpha_\varepsilon) = \varphi(\alpha_\varepsilon)/[1 - \Phi(\alpha_\varepsilon)]$; and $\delta(\alpha_\varepsilon) = \lambda(\alpha_\varepsilon)[\lambda(\alpha_\varepsilon) - \alpha_\varepsilon]$.

**Table 1 Number of firms across activities in the Canadian functional foods and nutraceuticals sector**

| Sector | Number of firms |
|---|---|
| **Nutraceutical activities only** | **78** |
| Nutraceuticals that are extracted or purified from plants (for example beta-glucan from oats, antioxidants from blueberries, isoflavanoids from soy, sterols from wood pulp, essential fatty acids from primrose oil, soluble fiber from fenugreek, etc.) | 64 |
| Nutraceuticals that are ground, dried, powdered, and pressed from plant materials (for example Echinacea, fenugreek, valerian, black cohosh, and gingseng, etc.) | 71 |
| Nutraceuticals that are produced extracted or purified from animals and microorganisms (for example Elk velvet, essential fatty acids, enzymes, carotenoids, etc.) | 39 |
| Nutraceuticals that are produced, extracted or purified from marine sources (for example. Glucosamine, chitosan, products from algae, seaweed, kelp, fish oils, etc) | 53 |
| | |
| **Functional food activities only** | **27** |
| Foods that have added active ingredients other than vitamins or minerals and have been scientifically demonstrated to provide health benefits beyond their basic nutritional functions (for example Muffins with beta-glucan, drinks with herb blends, foods with added soluble fibre, etc.) | 63 |
| Foods specially enhanced to contain more of a functional component, through plant breeding techniques, genetic modification, processing, or special live stock feeding techniques, that have been scientifically demonstrated to provide health benefits beyond their basic nutritional functions (for example tomato with enhanced lycopene level, canola high in carotenoids, strawberries containing increase levels of ellagic acid, omega-3 eggs, etc.) | 20 |

Source: authors' calculations.

Through preliminary analysis of the FFNS data, the seven groups of firm characteristics discussed in the conceptual framework were selected as explanatory variables for the *attpt* (attempt to raise capital) and *dollar* (amount of capital raised) models. Descriptive statistics for each group of explanatory variables are reported in Table 2. We assert that these characteristics distinguish firms in a manner that empirically-useful inferences can be derived through the analysis. However, we do not have definitive *a priori* expectations of the direction and magnitude of the effect each of these variables has in the two regression models outlined above. Thus, our motivation in identifying these seven groups of firm characteristics is to capture the widest possible variability in the sample, whereby we can be reasonably assured that the key factors that are likely to have a systematic association with our dependent variables are unlikely to have been excluded. Moreover, being a pioneering study in the financing of functional foods and nutraceutical innovations, we do not have previous studies to guide our analysis and formulate hypothesis about expected effects.

## Table 2 Description of explanatory variables

| Name | Description | Type | No | Mean | Std Dev. |
|---|---|---|---|---|---|
| | ***Dependent variable*** | | | | |
| attpt=1 | If firm attempted to raise capital in 2002 otherwise zero | dummy | 143 | 0.315 | 0.466 |
| dollar | Amount of capital received by a firm requesting capital (in dollars) | scale | 26 | 1247462 | 2610639 |
| | ***Independent variables*** | | | | |
| | **Firm Size and Involvement in Functional Foods and Nutraceutical Sector** | | | | |
| size | Number of all employees of the firm (in 2002) | integer | 145 | 491.628 | 2850.137 |
| ffnint | Number of employee in FFN activities/Total Employees | ratio | 134 | 0.640 | 0.407 |
| | **Prospects for Business Expansion** | | | | |
| inboom | Number of new hirings in 2002 for FFN activities | integer | 131 | 1.946 | 5.032 |
| unfill=1 | If firm has currently unfilled positions for FFN activities | dummy | 144 | 0.229 | 0.422 |
| | **Activities** | | | | |
| rd=1 | If firm participate in R & D activities otherwise zero | dummy | 146 | 0.534 | 0.501 |
| prdev=1 | If firm participate in product development/scale up otherwise zero | dummy | 146 | 0.651 | 0.478 |
| igmfg=1 | If firm manufacture ingredients otherwise zero | dummy | 146 | 0.274 | 0.448 |
| crdyp=1 | If firm manufacture consumer ready products otherwise zero | dummy | 146 | 0.562 | 0.498 |
| whole=1 | If firm is a wholesaler of products otherwise zero | dummy | 146 | 0.479 | 0.501 |
| retail =1 | If firm is a retailer of products otherwise zero | dummy | 146 | 0.260 | 0.440 |
| | **Business Ownership** | | | | |
| multina=1 | If firm is a multinational otherwise zero | dummy | 146 | 0.116 | 0.322 |
| pvt=1 | If firm is a private corporation otherwise zero | dummy | 146 | 0.719 | 0.451 |
| pubco=1 | If firm is a public corporation otherwise zero | dummy | 146 | 0.110 | 0.313 |
| ptshp=1 | If firm is a unincorporated partnership otherwise zero | dummy | 146 | 0.089 | 0.286 |
| cnd=1 | If firm ownership is Canadian (excluded foreign) otherwise zero | dummy | 146 | 0.856 | 0.352 |
| | **Distribution Channels** | | | | |
| direct=1 | If firm sells to customers directly | dummy | 146 | 0.438 | 0.498 |
| rtwh=1 | If firm sells through retailers/wholesalers | dummy | 146 | 0.692 | 0.463 |
| export=1 | If firm is an exporter (excluded non-exporting) | dummy | 146 | 0.541 | 0.500 |
| | **Business Practices** | | | | |
| partner=1 | If firm has been in a partnership | dummy | 144 | 0.375 | 0.486 |
| contrac=1 | If firm has contracted out functional foods and nutraceutical activities | dummy | 139 | 0.396 | 0.491 |
| grtipr=1 | If firm has granted intellectual property rights to other firms | dummy | 142 | 0.049 | 0.217 |
| aqipr=1 | If firm has acquired intellectual property rights from other firms | dummy | 136 | 0.169 | 0.376 |
| patents | Number of existing and pending patents | integer | 146 | 1.315 | 6.494 |
| | **Disease Focus of Products** | | | | |
| multipro=1 | If firm has products lines for more than one disease status | dummy | 146 | 0.719 | 0.451 |
| heart=1 | If firm has products lines for vascular and heart health | dummy | 146 | 0.541 | 0.500 |
| diabet=1 | If firm has product lines for diabetes | dummy | 146 | 0.363 | 0.483 |
| cancer=1 | If firm has product lines for cancer | dummy | 146 | 0.329 | 0.471 |
| gut=1 | If firm has product lines for gut health | dummy | 146 | 0.390 | 0.490 |
| immun=1 | If firm has product lines for immune system | dummy | 146 | 0.466 | 0.501 |
| bone=1 | If firm has product lines for bone health | dummy | 146 | 0.349 | 0.478 |
| **Valid N (listwise)** | | ... | 106 | ... | ... |

Source: authors' calculations.
... not applicable

In the analysis, firm size (*size*) and intensity of involvement in the functional food and nutraceutical sector intensity (*ffnint*) is derived based on the total number of employees and the number of employees who are engaged in activities specifically related to functional foods and nutraceuticals. Firm size is based on the total number of employees in 2002, including permanent and seasonal/casual/contract employees. Average firm size is 492 employees (SD=2,850) with substantial variation within the sample. The ratio of employees engaged in activities directly related to functional foods and nutraceuticals to total employees is used as a measure of intensity of involvement in the functional food and nutraceutical sector (*ffnint*). The sample average of measured intensity is 64.3 percent.

The prospect for a firm to expand its business is measured in terms of the number of new hirings (*inboom*) and the number of unfilled vacancies (*unfill*) in 2002 with respect to activities directly related to functional foods and nutraceuticals. These variables are included as both the number of new hirings and unfilled positions will reflect the anticipated human capital needs of the firms. Our contention is that such anticipated capacity is a measure of the potential for business expansion (and, following Spence (1977) and Dixit (1980) may carry with it strategic implications related to human capital capacity which make the firm more appealing to potential investors). The firm's activities related to the development and/or commercialization of functional foods and nutraceuticals is characterized using six dummy variables related to participation in research and development (*rd*), product development/scale up (*prdev*), ingredient manufacture (*igmfg*), manufacture of consumer-ready products (*crdyp*), wholesaling (*whole*), and retailing (*retail*). Around 65 percent of the firms are involved in product development and scaling-up, but only around 26 percent in retailing.

The ownership structure of firms was represented with five dummy variables. Around 86 percent of the firms are Canadian owned (*cnd*) and about 72 percent are private corporations (*pvt*). Relatively few (11.3 percent) are multinationals (*multina*) or public corporations (*pubco*), while around nine percent are unincorporated partnership (*ptshp*). The three main distribution channels used by the firms are direct sales to customers (*direct*), sales through retailers/wholesalers (*rtwh*) and exporting (*export*). Approximately, 54 percent of the firms were engage in exporting, while 44 percent sold direct to consumers through the internet or mail order.

In the analysis, a distinction is made between five business practices, namely whether the firm is in a partnership (*partner*), whether firm has contracted out functional food and nutraceutical-related activities (*contrac*), whether intellectual property rights have been granted to other firms (*grtipr*), whether intellectual property rights have been acquired from other firms (*aqipr*), and the number of existing and pending patents belonging to the firm (*patents*). Approximately 37 percent of firms had engaged in a partnership, while 40 percent had contracted-out functional food and nutraceutical-related activities. Significantly more firms had acquired intellectual property rights from other firms (17 percent) than had granted such rights to other firms (5 percent).

Finally, seven dummy variables are used to characterize the diseases on which the functional foods and/or nutraceuticals of the firms focus. The dummy variables have a value of one if the firm has product lines for more than one disease type (*multipro*), and if a firm has product lines for heart and vascular disease (*heart*), diabetes (*diabet*), cancer (*cancer*), gut health (*gut*), immune system conditions (*immune*) and bone health (*bone*). Across the sample, 72 percent of firms have products that focus on more than one disease type. The disease state for which the largest proportion (54 percent) of firms had products was heart and vascular disease.

Of the 146 firms responding to the FFNS survey, 45 firms (31 percent) had attempted to raise capital. The majority of these firms reported product innovation and commercialization as the principle reason for attempting to raise capital from external sources (Figure 1). Firms had sought financing through a variety of sources (Figure 2), most through banks, Canadian venture capital and government. The majority of firms raising capital were Canadian owned (86 percent) and private corporations (about 72 percent). The average size of firms that had attempted to raise capital was 39 employees, while average size of firms not seeking external financing was 445 employees. Moreover, the intensity of involvement in the functional food and nutraceutical sector among firms seeking capital was 80 percent, compared to 58 percent for firms not seeking external financing. This suggests that smaller firms with a greater focus on the functional food and nutraceutical sector had a greater propensity to seek external financing for their innovation and commercialization activities. Such a result is not unsurprising given the small scale of many of the start-up firms engaged in functional food and nutraceutical innovation and commercialization.

## Results of the Regression Analysis

*Probit Analysis of Seeking Capital*

The results of the probit regression on the dichotomous outcome of seeking finance (*attpt*) are reported in Table 3. Overall, the regression model explains the dichotomous outcome of seeking capital reasonably well (the psuedo-$R^2$ is 0.44, which is relative high for cross-sectional data). The Chi Square value for the goodness of fit test is significant with a p-value of 0.003. A number of the regression coefficients are intuitive, although others need careful elaboration. For instance, *size* had a negative coefficient significant at the five percent significance level, while the marginal probability for the size variable indicates that a one percent increase in firm size reduces the likelihood of a firm seeking capital by 0.0023 percent.[3] Presumably, larger firms are more likely to have internal budgetary resources to enable self-financing and would not have to access external capital sources, suggesting at the outset that issues and problems associated with external finance are more an issue for SMEs.

3. For sake of brevity, we only report marginal effects for the statistically significant variables.

**Table 3 Regression results for probit analysis of 'seeking capital' decision:**

| Name | Description | Coefficent | P-value | marginal probability % |
|---|---|---|---|---|
| Cons | Regression Constant | -2.005439 | 0.115 | ... |
| | **Firm Size and Involvement in Functional Foods and Nutraceutical Sector** | | | |
| size | Number of all employees of the firm (in 2002) | -0.0061166 | **0.012**** | -0.00229 |
| ffnint | Number of employee in FFN activities/Total Employees | 2.03415 | **0.006***** | 0.76197 |
| | **Prospects for Business Expansion** | | | |
| inboom | Number of employees hired in 2002 for FFN activities | 1.221267 | **0.015**** | 1.61426 |
| unfill=1 | If firm has currently unfilled positions for FFN activities | 0.1224831 | **0.029**** | 0.04588 |
| | **Activities** | | | |
| rd=1 | If firm participate in R & D activities otherwise zero | 0.5288859 | 0.271 | ... |
| prdev=1 | If firm participate in product development/scale up otherwise zero | -0.1799914 | 0.75 | ... |
| igmfg=1 | If firm manufacture ingredients otherwise zero | -0.7358607 | 0.184 | ... |
| crdyp=1 | If firm manufacture consumer ready products otherwise zero | 0.2109186 | 0.643 | ... |
| whole=1 | If firm is a wholesaler of products otherwise zero | 0.0355694 | 0.946 | ... |
| retail =1 | If firm is a retailer of products otherwise zero | 0.6609096 | 0.276 | ... |
| | **Business Ownership** | | | |
| multina=1 | If firm is a multinational otherwise zero | -1.912661 | 0.105 | ... |
| pvt=1 | If firm is a private corporation otherwise zero | -1.678879 | **0.049**** | -3.1028 |
| pubco=1 | If firm is a public corporation otherwise zero | -0.5358424 | 0.624 | ... |
| ptshp=1 | If firm is a unincorporated partnership otherwise zero | -1.192045 | 0.208 | ... |
| cnd=1 | If firm ownership is Canadian (excluded foreign) otherwise zero | 1.297047 | 0.205 | ... |
| | **Distribution Channels** | | | |
| direct=1 | If firm sells to customers directly | -0.2153158 | 0.676 | ... |
| rtwh=1 | If firm sells through retailers/wholesalers | 0.4506189 | 0.388 | ... |
| export=1 | If firm is an exporter (excluded non-exporting) | -0.7356804 | 0.156 | ... |
| | **Business Practices** | | | |
| partner=1 | If firm has been in a partnership | 1.92333 | **0.001***** | 3.19894 |
| contrac=1 | If firm has contracted out FFN activities | -1.139688 | **0.039**** | -0.46018 |
| grtipr=1 | If firm has granted intellectual property rights to other firms | 0.7066242 | 0.486 | ... |
| aqipr=1 | If firm has acquired intellectual property rights from other firms | -0.0985204 | 0.857 | ... |
| patents | Number of existing and pending patents | 0.0405107 | 0.202 | ... |
| | **Disease Focus of Products** | | | |
| multipro=1 | If firm has products lines for more than one disease status | -0.1637227 | 0.737 | ... |
| heart=1 | If firm has products lines for vascular and heart health | -0.096356 | 0.855 | ... |
| diabet=1 | If firm has product lines for diabetes | 0.0108554 | 0.987 | ... |
| cancer=1 | If firm has product lines for cancer | -0.6116602 | 0.23 | ... |
| gut=1 | If firm has product lines for gut health | 0.0348286 | 0.958 | ... |
| immun=1 | If firm has product lines for immune system | 0.5512856 | 0.373 | ... |
| bone=1 | If firm has product lines for bone health | -0.6875929 | 0.233 | ... |

Number of observations = 107
Log likelihood = -37.70755
Pseudo $R^2$ = 0.4425
Log Likelihood Ratio Test chi square 2(30) = 59.86
*** Significant at the one percent level
** Significant at the five percent level
... not applicable

The estimated coefficient on *ffnint* is positive and significant at the one percent level. This means firms with a greater share of their business related to functional food and nutraceutical activities (*ffnint*) have a higher likelihood of seeking capital. In particular, a one percent increase in the intensity of participation in the functional food and nutraceutical sector (*ffnint*) would increase the likelihood of a seeking external finance by 0.76 percent. Perhaps not unsurprisingly, firms with the greatest prospect for expanding their business related to functional foods and nutraceuticals (*inboom* and *unfill*) have a statistically significant and positive coefficient estimates. Firms with a higher number of new hirings or with unfilled positions in the FFN sector are more likely to search for capital. Moreover, the impact of potential for business expansion is not trivial in shaping the probability of seeking financing. For instance, a one percent increase in the number of new hirings with responsibilities directly related to functional foods and nutraceuticals would increase the probability of seeking capital by 1.6 percent. Indeed, many of the firms in this sector are new or very young firms, small in size and typically face internal financing constraints. This highlights the crucial role played by the availability of external financing for the expansion of business activities in the functional food and nutraceutical sector.

Interestingly, the various functions performed by the firms related to functional food and nutraceutical had no significant impact on the propensity to seek capital. This is perhaps contrary to *a priori* expectations. For example one might expect firms engaged in research and development to have a greater likelihood of searching for capital; while the coefficient for the dummy corresponding to involvement in research and development (*rd*) is positive, it is not significant.

Firm ownership has a somewhat puzzling association with the likelihood of seeking capital. It is plausible that multinational corporations are less likely to need external financing, and indeed the corresponding coefficient has a negative sign, although is not significant at the five percent level. Conversely, one would expect private corporations to be more likely to seek capital. The regression results, however, contradict this *a priori* hypothesis; the coefficient for the dummy variable *pvt* has a negative sign and is significant at the five percent level. Switching from any other ownership arrangement to being a private corporation would decrease the likelihood of seeking capital by 3.1 percent. Canadian-owned firms have a greater propensity to searching for capital, yet the coefficient is not significant at the five percent level.

There are no systematic associations between distribution channels used by firms in the functional food and nutraceutical sector and the propensity to seek capital. Although, the coefficients for *direct* and *export* were negative, they were not significant at the five percent level. However, among the business practices of firms in the functional food and nutraceutical sector, being in a partnership is positively associated, and significant, with the likelihood of seeking capital. Moreover, the likelihood of seeking capital would increase by about three percent if a firm is in a partnership relative to a firm which is not. In this respect it is possible that the very purpose of forming a partnership is to secure access to finance. However, only about 14 percent of the firms in the FFNS reported that the purpose of their partnership was for accessing capital, while only eight percent of the firms who attempted to raise capital reported that the purpose of the partnership to which they belonged was to access capital. Indeed, the major rationale for establishing a partnership was to conduct scientific research and development (36 percent), access markets/distribution channels (28 percent) or production/manufacture (27 percent). These results suggest that firms seek capital to access needed services that they are reluctant to undertake in-house, perhaps because of the lack of internal capabilities or economies of scope. Moreover, it is important to note that the services being sought through partnerships could be viewed as an indirect means of accessing capital (either physical or human). A puzzling result is the negative and significant coefficient for the *contrac* variable. According

to the preceding result for partnerships, firms which contract out functional food and nutraceutical-related functions have a greater likelihood of seeking capital. Yet the negative and significant coefficient for *contrac* is contradictory to this argument. However, it may be that firms which can afford to contract out functional food and nutraceutical related activities do not suffer from a lack of capital and, therefore, do not seek capital.

Finally, there is no systematic association between the likelihood of seeking capital and the focus by firms on more than one disease state, nor the specific diseases on which the functional food and nutraceutical firm's focus. None of the disease-state dummy variables had significant coefficients at the five percent level. This is perhaps contrary to *a priori* expectations. For example, firms engaged in functional food and nutraceutical activities related to multiple diseases might be considered in greater need of external finance because of the scope of separable activities associated with products directed at different disease states.

*Heckman's two stage approach for seeking capital and amount of capital raised*

The Heckman two step method, as outlined above, is used to explore the influence of variables on the amount of capital raised by the firms in the Canadian functional food and nutraceutical sector. The two-step method is generally sensitive to specifying a correct model (Stata 8). Indeed, there were problems of collinearity when attempting to estimate the model which included all of the *a priori* variables, as specified in Table 2. An added complication was that, out of 146 firms, only 26 firms reported non-zero values for the amount of capital raised. Thus, through the estimation process, the least number of collinear variables were dropped and the model re-estimated. In this process we strived to keep variables representing all of the seven variable groupings. Nevertheless, the results must be interpreted with care.

In the Heckman two-step approach, the first stage is the probit estimation of the dichotomous outcome of the "seek"/"non-seek" decision. This process is characterized by Equation 5, with regressors ($\mathbf{W}_i$) taken from variables which are significant in the "seek" decision in Table 3, namely *size*, *ffnint*, *unfill*, *inboom*, *pvt*, *partner*, *contrac*. Non-collinear variables explaining the dollar amount raised, ($\mathbf{X}_i$) as characterized by Equation 4 are *rd*, *prdev*, *export*, *size*, *ffnint*, *partner*, *contrac*, *grtipr*, *aqipr*, *patents* and *multipro*. The results are reported in Table 4.

**Table 4 Regression results for Heckman two-step method**

| Variable | Coefficient | p-value |
|---|---|---|
| **Select** | | |
| constant | -1.13986 | 0.015** |
| size | -0.0029 | 0.08* |
| ffnint | 0.546596 | 0.277 |
| unfill | 0.273239 | 0.426 |
| inboom | 0.100671 | 0.004*** |
| pvt | -0.83798 | 0.025** |
| partner | 0.728806 | 0.05** |
| contrac | -0.11523 | 0.739 |
| **Dollar** | | |
| constant | 7846453 | 0.003*** |
| Rd | 1650107 | 0.086* |
| prdev | -2653396 | 0.028** |
| export | 997359.4 | 0.295 |
| Size | 10971.21 | 0.017** |
| ffnint | -4562925 | 0.003*** |
| partner | -1568823 | 0.139 |
| contrac | -1142717 | 0.256 |
| grtipr | 1076597 | 0.409 |
| Aqipr | -563971 | 0.733 |
| patents | 7498.192 | 0.841 |
| multipro | 1375927 | 0.196 |

Number of observations 118,
Wald test chi square (2, 15)= 40.76 (p=0.0003)
*** Significant at the one percent level
** Significant at the five percent level
* Significant at the ten percent level

The error terms of the two processes ($u_i$ and $\varepsilon_i$ of Equations 6 and 7) are perfectly correlated ($\rho$=-1) indicating that using OLS regression for the dollar amount received by these firms would result in be inconsistent estimates. The Wald test of the null hypothesis that all coefficients are jointly equal to zero is rejected with Chi Square value of 40.76 and p-value of 0.0003. The selection component of the Heckman procedure does not provide any additional information since all of these variables were taken from the previous probit model. With the exception of *ffnint* and *unfill*, the estimated coefficients concord with the results of the probit regression reported in Table 3. For the two variables with different coefficient signs (i.e. *ffnint* and *unfill*), the coefficient estimates are not statistically significant at the ten percent level.

In the dollar amount raised model (i.e. the continuous portion of the dichotomous-continuous decisions), coefficients on the variables *rd* and *size* are positive and significant at the ten and five percent,

respectively. These results are intuitive. When a firm is involved in research and development activities it needs more capital and is more likely to search with greater intensity for external funding, with the end result being a higher level of obtained capital. Larger firms are more likely to raise greater amounts of capital since they have a larger equity base to act as collateral and may be considered lower risk. A one percent increase in firm size would increase the amount of capital raised by about C$11,000, if a firm decided to seek capital, while firms engaged in R&D raised C$1.7 million more than firms not engaged in R&D. The coefficients for the variables *prdev* and *ffnint* are negative and significant at the five and one percent level, respectively. The inverse relationship between level of capital obtained and *prdev* likely reflects the risks inherent in developing a new product and scaling-up production to a commercial level. Financiers will be leery of funding unproven concepts, which would result in greater capital rationing to the firms engaged in product developing/scaling-up, hence the inverse relationship.

The negative and significant coefficient for the firm's intensity of involvement in the functional food and nutraceutical sector suggests that, *ceterius paribus*, involvement in this sector decreases the amount of capital firms can raise. This may reflect the novel nature of many of the products in this sector and the infancy of markets in this sector, making potential financers wary of making large investments in forms therein engaged. Indeed, we might expect quite significant asymmetric information and moral hazard problems, especially where firms are reluctant to release information on innovative products at the developmental stage.

However, results related to *ffint* do present a vexing dilemma for firms; firms with a high level of functional food and nutraceutical intensity are more likely to seek external financing, but obtain less capital than a firm which has a lower level of functional food and nutraceutical intensity. This again may reflect capital rationing by financiers based on an uncertain future. In particular, the functional food and nutraceutical sector is in its infancy. While growth rates thus far have been strong, the future remains less certain. As functional foods and nutraceuticals move through the product life cycle, growth rates will slow and returns will likely diminish. As well, uncertainty with respect to the regulatory environment in Canada and a broad (i.e. in Canada's export markets) may give financiers cause to discount anticipated rates of return to firms heavily engaged in this sector. Both of these factors may lead to capital rationing with respect to functional food and nutraceutical intensity firms, and hence the observed results.

The variables *multipro*, *patents*, *grtipr* and *export* have positive coefficients, while *partner*, *contrac*, and *aqipr* have negative coefficients, although none are significant at the five percent level. Thus, these components of the model do not appear to provide any useful information.

## Summary and Conclusion

Growth in consumer interest in functional foods and nutraceuticals has been seen as a significant business opportunity for the agri-food sector in Canada. As a result, the functional food and nutraceutical sector is expanding rapidly, although many of the new firms in the sector are SMEs and face typical difficulties obtaining financing for their innovation and commercialization activities. The aim of this paper is to understand better the factors which affect a firm's decision to seek external financing and the level of financing obtained as a result.

The first aim is explored using a discrete choice analysis of the decision to seek external funding. Results from this analysis indicate that smaller firms, firms organized as privately held corporations and those which contract out functional food and nutraceutical activities are less likely to seek external funding. However, firms which are more intensely involved in the functional food and nutraceutical sector, who have great prospects for business expansion and have been involved in a partnership are more likely to seek external financing.

The second aim is addressed by developing a sample-selection model where the choice to seek external financing is included in the first stage and the amount of funding to be obtained is included in the second stage. Larger firms are less likely to raise capital through external sources, but received greater amounts of capital when they decided to raise capital. Firms with a greater share of functional food and nutraceutical activities in their business are more likely to search for capital, but receive less capital than less intensive firms. Often, such functional food and nutraceutical intensive firms are small start-up ventures. Our finding with respect to intensity not only highlights the importance of some public support for capital requirements for such firms, but also the additional burden on smaller functional food and nutraceutical intensive firms. Smaller firms encounter more difficulties accessing capital. The role of the firm in the functional food and nutraceutical development and commercialization process plays a role in the amount of funding obtained. Firms engaged in pure research and development received more capital, while firms in the product development and scaling-up process received less capital compared to firms engaged in all other activities. This suggests that financiers may ration capital on a differential basis according to the firm's role. Alternatively, research and development based firms may have higher capital requirements and therefore seek, and obtain, access to larger amounts of capital, while product development and scale-up based firms have lower capital requirements and therefore seek less money.

The conceptual literature suggests that information asymmetry, the non-rival nature of knowledge, liquidity constraints and lack of collateral are reasons why there is under-investment in research and development and innovation (see for example Hall 2002; 2005). Moreover, these factors often underlie calls for government programs which enable firms to access capital for research and development and innovation. If such under-investment has occurred, then a natural question to ask is how the results reported here might aid in the development or shaping of policies and programs which might enable greater access to capital. We maintain that two key points stand out. First, such policies ought to be targeted to smaller firms. These firms are more likely to seek external financing, potentially demonstrating a greater unsatisfied need, but receive less capital than larger firms. Second, consideration ought to be given to directing access to capital to firms which are more specialized in the functional food and nutraceutical sector (i.e. the functional food and nutraceutical intensive firms). The latter firms are more likely to seek capital (again demonstrating a potential need), but receive less capital than firms which are more diversified. Given the scope for regulatory impediments to future growth opportunities in the functional food and nutraceutical sector, firms which specialize may be viewed by financiers as more risky precisely because of regulatory uncertainty at home and abroad. Despite the growth and scope for opportunity in this sector, the anticipated returns to firms which specialize in functional foods and/or nutraceuticals may be discounted due to the regulatory environment, the result being under-investment (or no investment). Since this under-investment stems from deficiencies in the regulatory environment, one could argue that not only do these deficiencies need to be addressed, but capital access programs could also be designed to facilitate socially optimal investment during the transition to a new regulatory environment.

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**Figure 1 Reasons for attempting to raise capital among Canadian firms in functional foods and nutraceuticals sector**

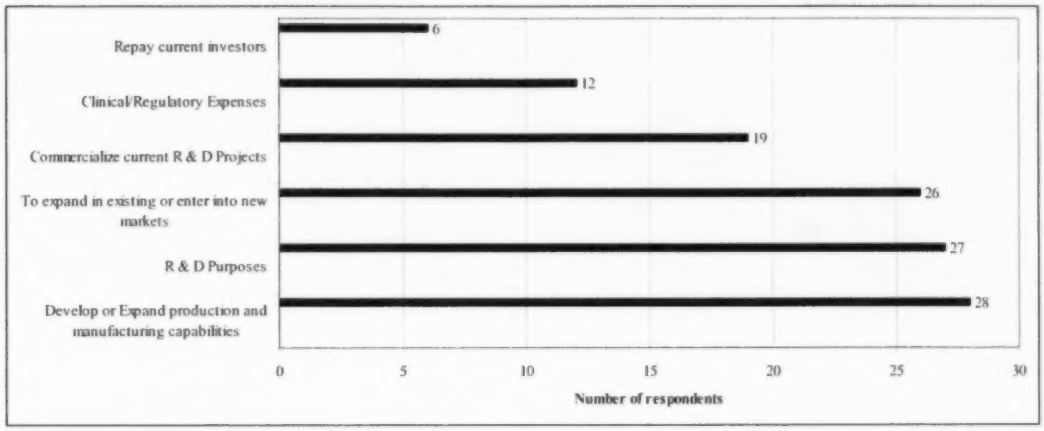
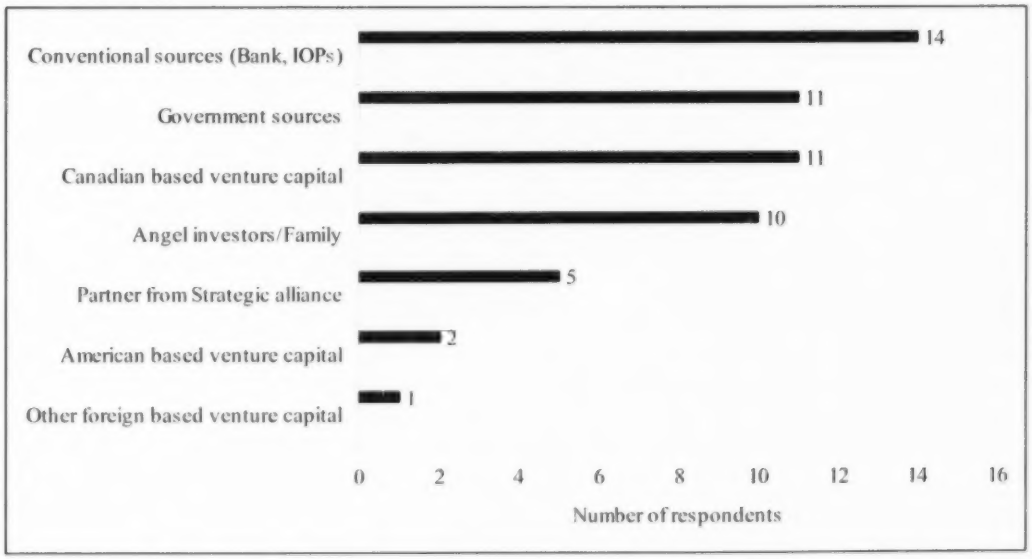



**Figure 2 Sources of capital for firms in the Canadian functional foods and nutraceuticals sector**



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